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N21Y N223 N224 N226 N245 N255 N2702 N2728
N2730 N2732 N2734 N281 N283 N32Y N389 N401
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U1S S1140 S3042**

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(58) Field of search

UK CL (Edition K) A3V

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(54) Protective material for body armour

(57) A protective material (4) for protection against sharp instruments (eg an attack by a knife) comprising at least one layer of a flexible armour material (1) itself comprised of flexibly linked overlapping plates or platelets (2) and one or more layers of anti-ballistic fabric (5). Staples (6) may hold the assembly together. The plates may be of metal, ceramics, plastics or fibre reinforced plastics. The fabric (5) may be multi-layered Kevlar (RTM). Other layers may include layers of parallel textile fabric within an intervening layer of fibres perpendicular to said parallel layers – see layer (7) figure 4.

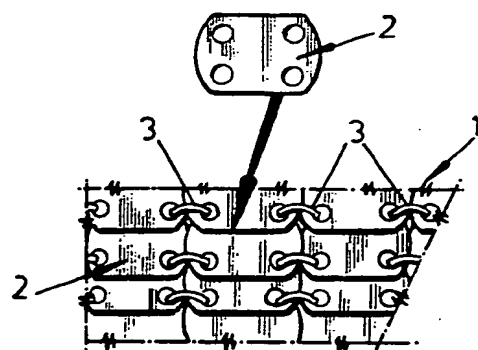


FIG. 1

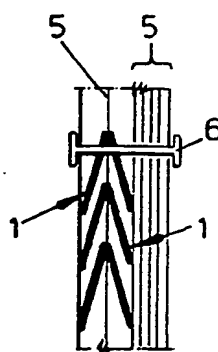


FIG. 3

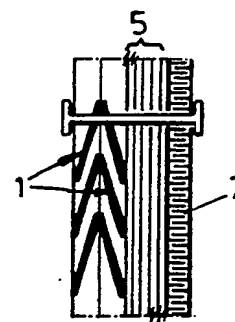


FIG. 4

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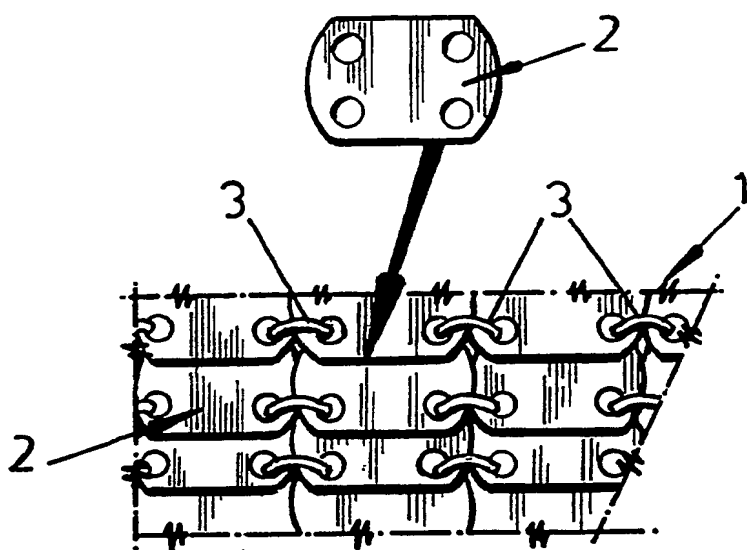


FIG. 1

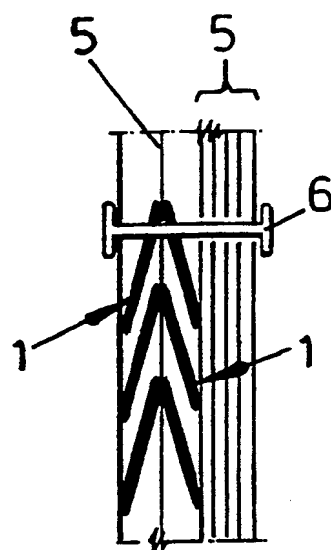


FIG. 3

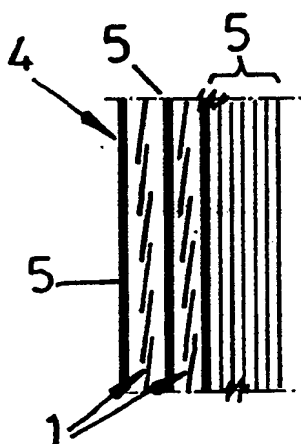


FIG. 2

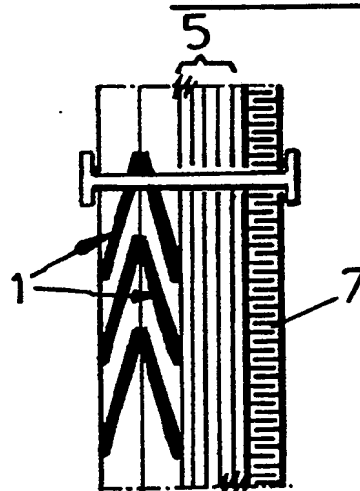


FIG. 4

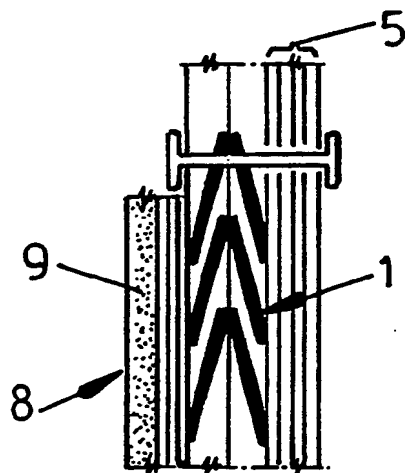


FIG. 5

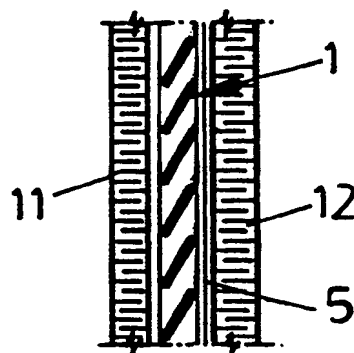


FIG. 6

PROTECTIVE MATERIAL

The present invention relates to a protective material.

The police, and other law enforcement personnel, require protection against weapons with which they may be attacked during the execution of their duty. For example, the personnel may have body armour for providing protection against a ballistic projectile. Such armour will generally comprise a number of layers of a ballistic fabric (eg. KEVLAR - Registered Trade Mark) and whilst the armour is perfectly satisfactory for resisting ballistic projectiles, it may not resist penetration by a knife in the event of an attack by stabbing on the officer.

It is therefore an object of the present invention to provide a material which is resistant to attack by stabbing.

According to the present invention there is provided a protective material for resisting attack by stabbing comprising at least one layer of a flexible armour material itself comprised of flexibly linked overlapping plates or platelets and at least one layer of an anti-ballistic fabric fixed to said armour material.

The plates or platelets of the flexible armour material are preferably of metal, plastics material, a resin impregnated material or a ceramic material. The platelets may for example be of a modified acrylic resin but most preferably are of metal.

The plates or platelets may be linked by rings (preferably of metal) so that the armour material is flexible in three dimensions. Alternatively, the plates or platelets may be linked together by rivets, staples, thread, cord or fabric hinges so as to provide for three dimensional flexibility of the armour material. The flexible armour material may be that available under the name SUPER LAMEX or ULTRA

LAMEX. ("LAMEX" is a registered Trade Mark).

The anti-ballistic fabric may be a woven, knitted or felt construction. The anti-ballistic fabric may be formed from fibres of aramid, polyethylene, glass, polypropylene, polybenzothiazole, nylon or polyamide.

Preferably, the anti-ballistic fabric is of an aramid material, for example KEVLAR. Further examples of anti-ballistic material which may be used are DYNEEMA SK60 or SPECTRA. ("DYNEEMA" and "SPECTRA" are registered Trade Marks.).

The flexible armour material is preferably affixed to the anti-ballistic fabric, eg. by adhesive bonding, sewing, or by the use of flexible staples.

The protective material may comprise at least two layers of the flexible armour material between which is a layer of the anti-ballistic fabric. Preferably these layers of the flexible armour material have their overlaps arranged in opposite directions. Such an arrangement insures that, in the event of a knife being able to "slip between" plates or platelets of one layer of the flexible armour, further passage of the knife will be prevented by the second layer.

The protective material may additionally be associated with a composite material which comprises a plurality of parallel layers of textile fabric and at least one further layer composed of fibres which are substantially perpendicular to the plurality of layers of textile fabric. Such a material is referred to herein for convenience as "double cloth" and is disclosed in UK-A-2 232 063. The "double cloth" may serve as a trauma pack for the protective material. The fibres of the "double cloth" may be impregnated with a resin, elastomeric material, rubber or polyamide material to restrict the movement of the fibres. Alternatively the fibres of the "double cloth" may be heat treated. Similar treatments may be applied to fibres of the anti-ballistic material.

The "double cloth" may be fixed to the anti-

ballistic fabric, for example by adhesive bonding or by sewing.

The protective material may also be associated with an anti-ballistic composite plate of known construction eg. comprising ceramic, glass or metal. The use of such a plate is particularly advantageous in cases where protection from ballistic projectiles is required as well as from sharp implements.

The protective material of the invention may be made up into a protective garment to be worn, for example, by a law enforcement officer.

The invention will be further described by way of example only with reference to the accompanying drawings, in which:

Fig. 1 is a view of a flexible armour material which may be used in the protective material according to the invention;

Fig. 2 is a schematic sectional view of one embodiment of protective material in accordance with the invention; and Figs.4-7 are similar to Fig.2 but illustrate further constructions in accordance with the invention.

The armour material 1 illustrated in Fig. 1 is of a chain mail type structure and comprises a plurality of overlapping thin aluminium plates 2 linked together by stainless steel rings 3. The thinness of the plates 2, together with the way in which they are linked by the rings 3, ensures that the material 1 is flexible. The material 1 may be of the type available from Metal Chainex (Paris, France) under the name SUPER LAMEX or ULTRA LAMEX.

Referring now to Fig. 2 there is illustrated (in schematic sectional view) one embodiment of protective material 4 in accordance with the invention which comprises two layers of armour material 1 in combination with a total of nine layers of an anti-ballistic fabric 5 (eg. KEVLAR). More particularly

the illustrated material comprises (as viewed from left to right in the Figure) a layer of anti-ballistic fabric 5, a layer of armour material 1, a further layer of fabric 5, a further layer of armour material 1, and seven further layers of anti-ballistic fabric 5. When the material is worn by an officer, the left hand layer of fabric 5 will generally be the outermost layer of the protective material.

The layers 1 and 5 may be fixed together in any suitable way. For example, the layers may all be stitched together (the stitching through layer 1 passing through the holes in the plates 2 through which the rings 3 pass). Alternatively, the various layers could be adhesively bonded together. If desired, adjacent layers of anti-ballistic fabric may be secured together (eg. by stitching or adhesive bonding) before assembly into the protective material.

The illustrated protective material has been tested for resistance to stabbing and has been found to meet the minimum requirement of the UK Police test in that the material is resistant to 42 Joules of energy from a knife blade fired from an air gun to simulate a stab attack.

Thus the material combines the advantage of being resistant to stabbing with being flexible to wear when made up into a garment, eg. a jacket or a vest.

A number of modifications may be made to the material illustrated in Fig.2. Thus, it may be possible for there only to be one layer of armour material 1 and one layer of anti-ballistic fabric 4. Such an arrangement may be suitable where the material is to be worn in combination with conventional body armour. Obviously any other combination of layers 1 and 4 may be used.

In the arrangement of Fig.3, two layers of armour material 1 are provided and arranged with their overlaps in opposite directions. In the event of a

knife thrust from (say) the left which penetrates upwardly between two of the platelets of the left hand armour layer 1, further penetration of the knife is prevented by the oppositely angled platelets of the right hand layer 1.

In the arrangement of Fig.3, a plastics staple 6 is shown as penetrating through the various layers 1 and 5. For preference, these staples 6 are provided around the edge of the material, rather than being the means by which the layers 1 and 5 are secured together throughout their areas.

In the arrangement of Fig.4, the protective material incorporates a layer of "double cloth" 7 as disclosed in UK-A-2 232 063 which serves as a trauma pack.

The arrangement of Fig.5 incorporates a high velocity pack 8 which incorporates a standard ballistic plate 9 faced with Kevlar layers 10. The provision of the high velocity pack 10 ensures that the material shown in Fig.6 may be used for protection against ballistic projectiles as well as sharp implements such as knives.

The material shown in Fig.6 comprises a single layer of armour material 1, a single layer of anti-ballistic fabric 5, and two layers of "double cloth" 11 and 12, the rear one 12, of which acts as a trauma pack. The front layer of "double cloth" may be impregnated with a resin, eg. Modar, which enhances resistance of the "double cloth" layer to penetration by a knife. The amount of resin applied should be such that the "double cloth" retains an element of flexibility.

In a modification of the above described structures, the two armour layers 1 may be of different materials. Furthermore, the illustrated constructions of protective material may be provided within a fabric cover.

CLAIMS

1. A protective material for protection against sharp instruments comprising at least one layer of a flexible armour material itself comprised of flexibly linked overlapping plates or platelets and one or more layers of anti-ballistic fabric.
2. A protective material as claimed in claim 1 wherein the plates or platelets are of metal, a plastics material, a resin impregnated material or a ceramic material.
3. A protective material as claimed in claim 1 or 2 wherein the plates or platelets are linked by rings, (preferably of metal) so that the armour material is flexible in three dimensions.
4. A protective material as claimed in claim 1 or 2 wherein the platelets are linked together by rivets, staples, thread, cord or fabric hinges so that the armour material is flexible in three dimensions.
5. A protective material as claimed in any one of claims 1 to 4 wherein the anti-ballistic fabric is a woven, knitted or felt construction.
6. A protective material as claimed in any one of claims 1 to 5 wherein the anti-ballistic fabric is formed from fibres of aramid, polyethylene, glass, polypropylene, polybenzothiazole, or polyamide.
7. A protective material as claimed in any one of claims 1 to 6 wherein the flexible armour

material is affixed to the anti-ballistic fabric.

8. A protective material as claimed in claim 7 wherein the flexible armour material is affixed to the anti-ballistic fabric by adhesive bonding, sewing, or stapling.
9. A protective material as claimed in any one of claims 1 to 8 comprising at least two layers of the armour material between which is a layer of said anti-ballistic fabric.
10. A protective material as claimed in any one of claims 1 to 9 comprising two layers of the flexible armour material arranged with their overlaps in opposite directions.
11. A protective material according to any one of the preceding claims incorporating at least one layer of material composed of fibres which are substantially perpendicular to the layer or layers of anti-ballistic fabric.
12. A protective material as claimed in any one of claims 1 to 11 additionally provided with a trauma pack.
13. A protective material as claimed in any one of claims 1 to 11 provided with an anti-ballistic composite plate, for example of ceramic, glass or metal.
14. A protective material according to any one of the preceding claims wherein the ballistic fabric is comprised of fibres which are heat treated.

15. A protective material according to any one of claims 1 to 13 wherein the ballistic fabric is comprised of resin impregnated or rubber impregnated fibres.
16. A protective material as claimed in any one of claims 1 to 15 wherein the ballistic fabric is faced with a plastics material.
17. A protective material as claimed in any one of claims 1 to 16 incorporating a closed-cell foam material for buoyancy.
18. A protective material as claimed in claim 11 wherein said at least one layer of material is composed of heat treated fibres.
19. A protective material as claimed in any one of claims 1 to 18 having a fabric cover.
20. A protective material substantially as hereinbefore described with reference to any one of Figs.1 to 6 of the accompanying drawings.
21. A shield comprising a protective material according to any one of claims 1 to 19.